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EFFECTIVENESS OF SOIL FUMIGATION WITH METHYL BROMIDE-CHLOROPICRIN AT MT. SOPRIS TREE NURSERY

White River National Forest

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Rocky Mountain Region

U.S. Department of Agriculture Forest Service

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INTRODUCTION

Soil fumigation has been used for many years to control pests in forest nurseries. Methyl bromide fumigation has been used for weed control at Mt. Sopris Tree Nursery which is operated by the USDA, Forest Service near Carbondale, Colorado; however, the use of this fumigant was discontinued in 1969 because of erratic results and high cost. From 1970 to 1972 a powdered fumigant called Mylone was used for weed control; this treatment was terminated because of economic considerations and concern about possible residual effects of soil fumigation on tree seedling vigor.

Since 1972 weed control has consisted mainly of applications of the preemergence herbicide Dymid. Although initially effective, these herbicide treatments failed to adequately control weeds in recent years, especially common purslane (*Portulaca oleracea* L.).

A seedling loss analysis conducted during the 1976 growing season revealed that damping-off fungi were causing losses as high as 75% of emerged seedlings. *Pythium* spp. and *Fusarium* spp. were the principal pathogenic fungi isolated from diseased soil, seeds and seedlings.

By the summer of 1976 the weed problem at Mt. Sopris had reached epidemic proportions. High weed seed populations, favorable weather conditions and ineffective herbicidal control all contributed to the problem. Accordingly, a decision was made to use soil fumigation during the fall of 1976 as a means to eradicate weeds on 25 acres of seedbed to be planted during 1977.

METHODS AND MATERIALS

A soil sampling grid was established in the nursery beds to monitor fumigation effectiveness. A series of three soil samples was collected to determine relative population levels of weed seeds and pathogenic fungi before and after fumigation. The 25 acres scheduled for sowing in 1977 consisted of six nursery blocks; each block contains 10 units which were delimited by the rows of irrigation pipe. One soil sample was collected from the middle of each nursery unit and these samples were pooled to yield one aggregated sample per nursery block.

The individual samples were taken by forcing a 1-inch diameter soil probe through the soil profile to a depth of 6 inches. The soil core was extracted from the probe and placed in a paper bag. When all samples had been collected in a given block the bag was labeled and stored in a refrigereated ice chest for transportation to the laboratory.

Three separate analyses were conducted on the soil samples at the Forest Insect and Disease Management laboratory. Portions of the soil were cultured on selective media to determine the population levels of *Pythium* spp. and *Fusarium* spp.; each culture was replicated three times. The number of fungal colonies per culture plate was recorded and used to compute the fungal population. [1,2] The remainder of the soil sample was spread out in a pan to a depth of 1-2 inches, watered, covered with plastic wrap and incubated under fluorescent light. After two weeks, the number of emerged weed seedlings was recorded; no attempt was made to distinguish weed species.

The six nursery blocks, Blocks 1, 2, 10, 14, 18-18A, and 19 were fumigated with MBC-33 (67% methyl bromide and 33% chloropicrin) at an application rate of 400 pounds per acre during the last week in August, 1976 by Hendrix and Dail, Inc., soil fumigation specialists from Greenville, North Carolina. The gaseous fumigant was injected 6 inches into prepared soil and covered immediately with a plastic tarp (Figure 1). The tarp was left in place for three days to allow adequate diffusion of the fumigant throughout the soil profile.

One week after the fumigation tarps were removed, soil samples were collected and analyzed as previously described for the prefumigation samples.

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[1]Hendrix, F. F., Jr. and E. G. Kuhlman. 1965. Factors affecting direct recovery of *Phytophthora cinnamomi* from soil. Phytopathology 55:1183-1187.

[2]Nash, S. M. and W. C. Snyder. 1962. Quantitative estimations by plate counts of propagules of the bean root rot *Fusarium* in field soils. Phytopathology 52:567-572.

Figure 1 - The MBC-33 fumigant (67% methyl bromide and 33% chloropicrin) was injected 6 inches under the nursery soil and was covered with a plastic tarp.

RESULTS AND DISCUSSION

Damping-off fungi

Counts of fungal colonies from the prefumigation soil samples yielded a high population of *Pythium* spp.; the six nursery blocks had *Pythium* populations ranging from 26 to over 96 fungal propragules per gram of soil with an average value of 57.7 (Table 1). A similar study at the USDA, Forest Service Bend Nursery had prefumigation *Pythium* levels of only 26.9 prop/g (1).

The postfumigation soil tests showed a significant reduction in the *Pythium* populations with all but one nursery block showing levels of 0 prop/g. The only exception was Block 18-18A where the population dropped from 26.0 to 20.7 prop/g. This discrepancy could be attributed to poor fumigant dispersal or unrepresentative sample collection.

TABLE 1 - Fumigation effectiveness for damping-off fungi and weed seeds at Mt. Sopris Tree Nursery, September 1976

Type of Pest	Sample	Units	NURSERY BLOCK 1	2	10	14	18-18A	19	$\bar{X}$
Damping-off fungi									
1. *Pythium* spp.	Pre-fumigation	propagules per gram of soil	67.3	46.7	40.6	96.7	26.0	68.7	57.7
	Post-fumigation		0.0	0.0	0.0	0.0	20.7	0.0	3.4
2. *Fusarium* spp.	Pre-fumigation	colonies per plate	15.7	9.6	3.6	9.4	17.3	10.6	11.0
	Post-fumigation		1.4	8.3	1.0	0.0	2.6	0.0	2.2
Weed Seeds	Pre-fumigation	germinants per sample	62	10	8	5	6	18	18
	Post-fumigation		0	0	0	0	0	0	0

The *Fusarium* spp. populations also showed a considerable reduction after fumigation; the average pre-treatment level of 11.0 fungal colonies per culture plate (.0025 g. soil per plate) was reduced to 2.2 colonies/plate (Table 1). Four of the six fumigated nursery blocks had small residual populations of *Fusarium* with Block 8 showing only a slight reduction from 9.6 to 8.3 col./plate. In another study at Bend Nursery a small residual *Fusarium* population was considered sufficient to repopulate the soil to prefumigation levels within one crop rotation (2). Low residual populations of pathogenic fungi could theoretically return to damaging levels because of the elimination of microbial competition within the nursery soil. Additional soil samples should be collected and analyzed for damping-off fungi prior to planting; if levels are high, it may be necessary to treat with a soil drench fungicide.

Weed Seeds

Weed seed germination tests made on soil samples taken before and after fumigation indicate complete weed eradication in all nursery blocks. Prefumigation levels of from 5-62 germinants per sample were reduced to 0 after fumigation in all blocks (Table 1).

It should be emphasized that soil samples were only taken to a 6-inch depth and that dormant weed seeds may still exist in deeper soil strata. Care should be exercised in seedbed preparation to avoid bringing these seeds to the surface. Fumigation virtually eliminated weed seed to a depth of at least six inches in two Northern Rocky Mountain nurseries (3).

Contamination from windborne weed seed may occur over the winter at the nursery. An abundant reservoir of weed seed exists in adjacent fields and strong winds are common in winter months. Periodic weed counts taken the summer following fumigation at Coeur d'Alene and Savenac nurseries showed that weed populations had returned to normal levels by fall due to windblown weed seeds (3). Observations of weed populations trends should be made in all fumigated beds and supplemental herbicide applications made if conditions warrant.

One interesting observation made during postfumigation sampling was the presence of emerging pea seedlings in several of the fumigated blocks. These peas originated from residual seed from the green manure cover crop of the previous season. Legumes are noted for having hard seed coats and are resistant to adverse environmental conditions. These seeds were merely scarified by the fumigation and thus stimulated to germinate; the resulting seedlings will be killed by the first frost.

Beneficial Aspects of Fumigation

Nursery fumigation can be economically justified by weed control alone when compared to the high labor cost of hand weeding. Based on actual daily production figures, a crew of 17 weeders covered 7.5 seedbeds or 0.37 acres in one day. At an average $4.50 per hour wage, hand weeding costs $1,654 per acre. Fumigation costs averaged slightly over $800 per acre yielding a favorable 2:1 benefit-cost ratio. Considering that most seedbeds require 2-3 weedings per year the B/C could be even more favorable depending on the length of time that the seedbed remains weed-free after fumigation. At Coeur d"Alene and Savenac nurseries the savings in labor ranged from $700 - $1,000 per acre (3).

There are other subsidiary benefits of nursery fumigation. If the cost of methyl bromide-chloropicrin fumigation can be justified through hand weeding savings, then the fungicidal effects are an additional bonus. Pathogenic nemathodes are also controlled by fumigation. Seedlings grown in fumigated seedbeds have been shown to be significantly larger than those grown in unfumigated soil (3).

CONCLUSIONS AND RECOMMENDATIONS

1. Fumigation with MBC-33 at 400 pounds per acre proved to be very effective in eradicating weed seeds and reducing populations of damping-off fungi in seedbeds at Mt. Sopris Tree Nursery.

2. Supplemental tests for damping-off fungi, especially *Fusarium* spp., should be conducted prior to sowing to detemine if a significant increase in the population occurred since the fumigation.

3. Weed seed germination tests should be made prior to sowing to determine if windborne weed seed contaminated the fumigated soil.

4. Plots should be established in all fumigated seedbeds to monitor weed populations and determine fumigation effectiveness over the rotation.

REFERENCES

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